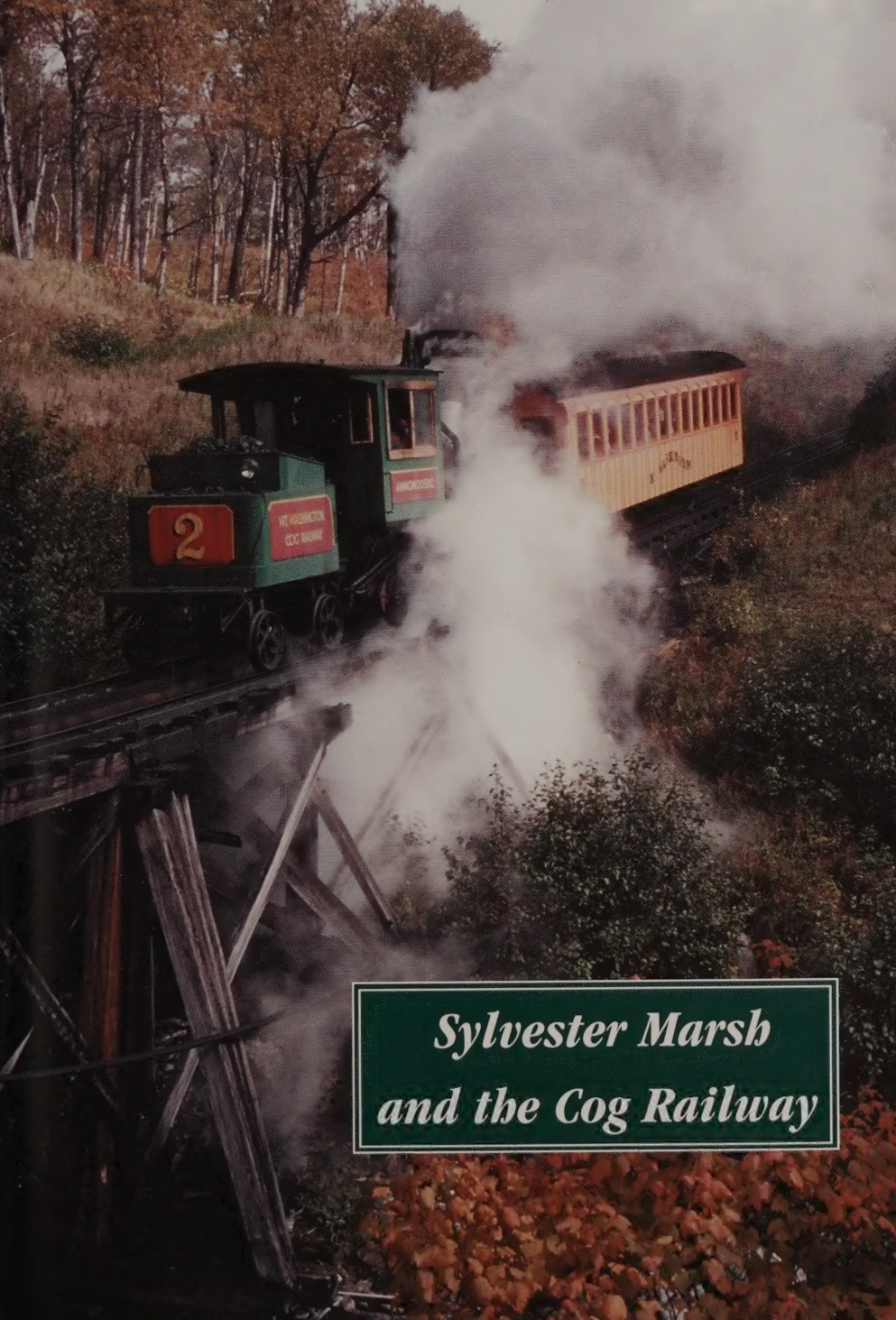


Sylvester Marsh and the Cog Railway

FOOT OF THE MOUNTAIN.

INTO CLOUDLAND BY CARS.

We started (six of us, including our driver), after an early breakfast at Littleton, hoping to reach the foot of Mount Washington in time for an afternoon train to the summit.

Our twenty-mile ride—with the grand mountains rising before us, changing in form with every turn of the winding road, swelling and subsiding like gigantic sea-waves, as the varying cloud-shadows moved across them—had intensified all our previous desires, and the ladies vowed with great vehemence that to the top they would go, though they should do it upon their hands and knees. And so it seemed they must, for when we reached the toll-gate at the commencement of the turnpike, near the old Fabyan stand, the good-natured gate-keeper, with many sympathetic regrets, said the cars had gone up. A glance at our disappointed faces induced a doubtful "perhaps they *may* go up again this afternoon." This, with a tin cup of delicious mountain strawberries which he had just gathered, gave us some encouragement. On we went, by the beautiful Ammonoosuc, calculating our chances, and watching the thread on the mountain, scarcely believing it possible any thing more than Queen

ON THE WAY UP.

Mab's fairy coach could descend upon it, but each moment hoping to see the smoke, which would show us the train was descending, and might therefore be ready to take us up.

Arriving at the depot (we speak prophetically) a busy scene met our eyes: piles of lumber, newly-erected sheds, workmen going and coming and plying the hammer and the saw, but, alas! no cars. We went into the log-cabin, where the ladies were amused to find telegraph-office, store-room, parlor, and sleeping-room in a curious state of admixture, where we were informed that the Superintendent of the road, Mr. J. J. SANBORN, would soon be down with the train from the summit. We found here Mr. MARSH, the projector of the road, and from him gained some idea of what an undertaking it had been. When, twelve years ago, he applied for a charter from the New Hampshire Legislature, a worthy member proposed to amend Mr. MARSH's petition by substituting "the moon" for "the top of Mount Washington."

MOUNT WASHINGTON RAILROAD.

Where is that member, and those who laughed with him?

Mr. MARSH obtained his charter, purchased 17,000 acres of land from the base to the summit, broke ground, and built a mile of the road before railroad men could be convinced of its practicability.

Then a company was formed, and under Mr. J. J. SANBORN, the present

JACOB'S LADDER.

Continued on back endpapers.

Sylvester Marsh, 1871. (W. Weller photo.)

9/08

Sylvester Marsh

and the Cog Railway

Richard S. Joslin

Campton, N. H., mid-19th century. The Marsh farm was just beyond the nearest hill. (Young photo.)

1. Invention

Since the time when the Cog Railway was completed, in 1869, much of the history of the project and its inventor, Sylvester Marsh, has become garbled or lost. Some myths have been added. It's a challenge to reconstruct the story from original documentation: state papers, hearing and court testimony, patents, deeds, company records, private correspondence, and contemporary news articles. Throughout his adult life, Marsh appears to have been in the papers. The following history, based on surviving documentation, is a summary of the story.

Sylvester Marsh was born on September 30, 1803, and lived eighty-one years. His life spanned the American industrial revolution, and his inventions—especially the Mount Washington Railway—reflected it.

Influences that shaped the man.

Marsh was a New Hampshire native son, living the first nineteen and the last twenty years of his life in the state. The son of Mehitable and John Marsh, he was the ninth of eleven children. He grew up on his parents' farm in Campton, in

the foothills of the White Mountains. For three months each winter of his childhood, he attended a one-room district school. There he learned, he said, "arithmetic, geography and the first rudiments of grammar; reading, writing, spelling, and oratorical speaking." His family members were "old fashioned Congregationalists," and he was much influenced by the Second Great Awakening revival that swept New England in his youth. In 1823 Marsh's mother died. His father sold the farm and went to live with his oldest son.

At age nineteen Marsh left Campton and walked the 117 miles to Boston, the commercial capital of New England. Within a few years he had worked his way up in the provision-and-meat trade. By 1827, the year after Boston's Quincy Markets opened, he ran a stall there. His first employers, two brothers, Francis and William Jackson, may have become role models. Both were successful businessmen and leaders in the local Congregational society. Francis was one of the founders of the Abolitionist movement in America and an early supporter of women's suffrage. William, a sometime Whig politician, was one of the builders of Boston's first

Quincy Markets, Boston, mid-19th century. (Bates photo.)

steam railroad, the Boston and Worcester (B&W), later to become the Boston and Albany. Marsh developed a similar liberal bent and became fascinated by the technologies he saw developing around him. When construction of the first mill city in America, Lowell, had just started, Marsh spent two days examining the project. Before the B&W Railroad was built, when the locomotive DeWitt Clinton began hauling cars from Albany, New York, to Schenectady, opening the first steam railroad in the North, Marsh was one of the passengers. In 1828 Marsh went west on the newly completed Erie Canal to settle in Ashtabula, Ohio. He continued as a provision dealer, and he began packing meat.

Business card.

"... at the top of the market, without inspection."

In 1833 he moved on to Chicago, a frontier town with 300 inhabitants—smaller than the Campton he had left. Continuing in the provision and packing trades, Marsh became one of the founders of Chicago meatpacking. In 1848 Chicago's first railroad, the Galena and Chicago Union, later to become the Chicago and Northwestern, was built to the prairies northwest of the city. The railroad terminated behind Marsh's property on the Chicago River. Marsh built a packing plant there, where corn-fed cattle and hogs could be delivered directly from the prairies. An 1850 Chicago newspaper told of Marsh's new steam-operated, three-story

plant: "... for the business of packing it is perhaps the best house in the city. ... He sells his beef in Boston, at which place his brand is so well known and so highly esteemed as to sell readily at the top of the market without inspection." Marsh later patented one of his improvements, a lard-rendering device.

"... one of the benefactors of his species."

By the 1850's Chicago was not only a center of meat-packing, it also was becoming the largest grain port in the world. A problem that hindered shipping grain, especially overseas, was its tendency to sour or spoil while in storage. "A perfect safeguard against the heating of corn has been discovered by our fellow citizen Sylvester Marsh," reported the *Chicago Press and Tribune* in 1860, describing his new sixty-foot-tall grain kiln. The article explained, "Having secured a handsome fortune, he ceased packing beef and pork in 1853. For the last several years he has devoted a large share of his time, and not a little of his income, to experiments upon drying corn. ... He has shipped meal to California around Cape Horn and stored it there a year, and when it came back it was just as good as when first ground. ... Mr. Marsh is now supplying Corn Meal for whaleships, for long voyages, confident that it will remain sweet for any length of time, and in any climate. ... The effect of his discovery upon the demand for our great staple in Europe can

Grain dryer, Buffalo, New York, c. 1860.

scarcely be over-estimated." The writer concluded, in the rhetoric of the time, "We regard this as one of the most important discoveries of the age, and its enterprising, ingenious inventor will live in history as one of the benefactors of his species."

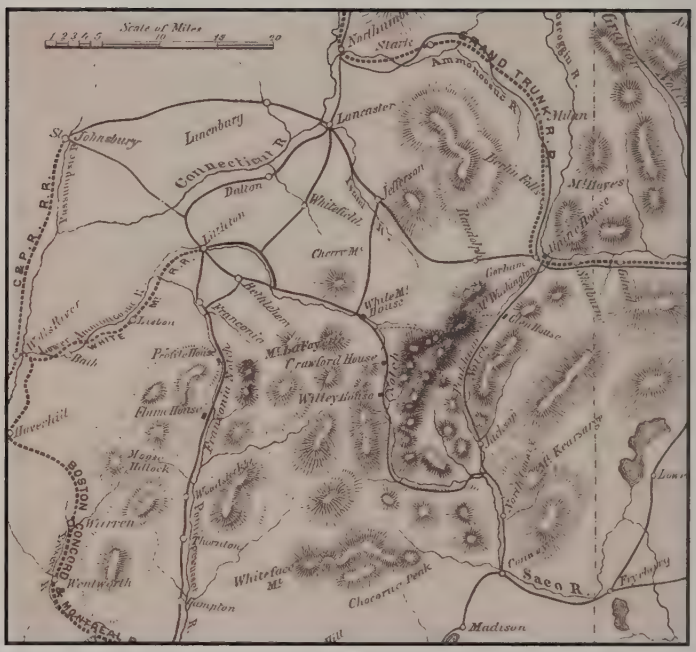
Of eleven U.S. patents Marsh would receive, six were for grain dryers. He erected large dryers in Chicago, Buffalo, and Brooklyn, New York, and probably elsewhere. "Marsh's Caloric [meaning using heat] Grain Dryers" and his grain shipping company provided a substantial income.

Family, retirement, and an incident.

In 1844, Marsh had married Charlotte D. Bates of Monson, Massachusetts. They had two children, Mary and John Franklin (called Frank), before his wife died in 1850. The widower then married Cornelia Hoyt, originally from St. Albans, Vermont. She had come to Illinois with her parents, and in 1846 had graduated from Illinois's Monticello Seminary. Subsequently she had taught at Monticello, a women's college then informally associated with Mount Holyoke Seminary. The couple had four children: Sylvester, Jr., Cornelia, Jessie and Harriette (called Hattie). A workaholic all his life, in 1855 Marsh resolved to retire. With his family he moved to the Jamaica Plain section of West Roxbury, a new suburb of Boston, but the sudden inactivity

Frank and Mary Marsh, 1850.

Cornelia H. Marsh and Sylvester, Jr., 1857.



Map of White Mountain area, 1859.

caused a physical upset diagnosed as "dyspepsia." Soon Marsh was eager for a new project.

In August 1857, accompanied by his Boston pastor Augustus Thompson, he went for a tramp in the White Mountains. A few years earlier, railroads had reached Gorham, north of the mountains, and Littleton to their west. Tourism was under way. A carriage road built part way up the east side of Mount Washington was believed to have been abandoned. (Completed in 1861, it's now the Mount Washington Auto Road.) On an afternoon that began clear, the two men hiked up the Crawford Path. Above the tree line, they suddenly were overtaken by a terrific storm—hurricane-force winds, freezing rain and premature darkness. Staggering, sometimes crawling, they lost their way until they stumbled into the Tip-Top House, exhausted. Marsh thereby had found his mission: to provide, as he wrote, "some easier and safer method of ascension."

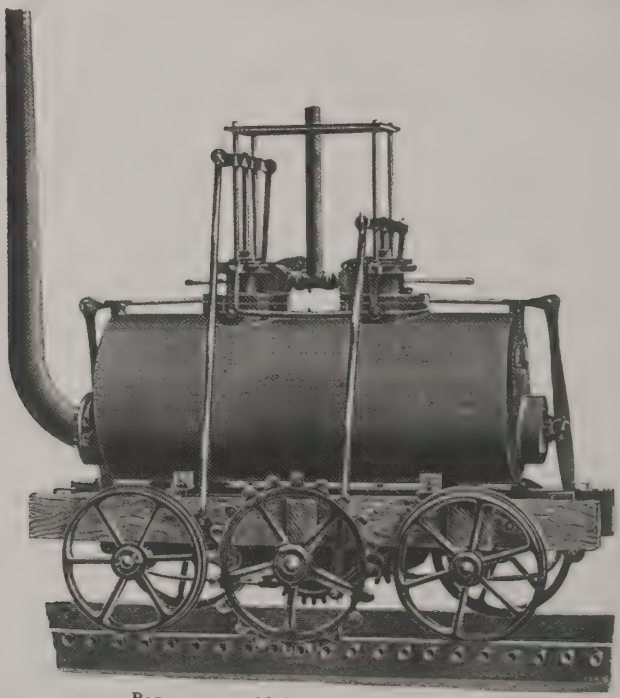
A range of solutions.

He explored several alternatives. First, he considered building a funicular railway. The first steam-powered funicular railway in America built specifically for tourists had opened just the year before at Mount Holyoke in Massachusetts. Visitors arrived there on a main-line railroad and then, in a car pulled by a rope worked by a stationary engine, were carried up to a hotel on the summit overlooking the oxbow of the Connecticut River. Mount Holyoke, at one-tenth Mount Washington's height, was the precedent and model for Marsh's project. The highest commercial funicular railway in the country, built in 1834 at Portage, Pennsylvania, crossed the Allegheny Mountains in a series of ten switchback lines. Marsh considered switchback layouts. Cars would be pulled up the mountain by a series of cables, worked by stationary engines, but soon Marsh realized that "a chain of such length [as needed for Mount Washington] could not sustain its own weight, much less draw up a load of passengers." In addition, "there was no means of getting the engines into place." He concluded he needed an engine that could propel itself up the mountain as the roadway was built.

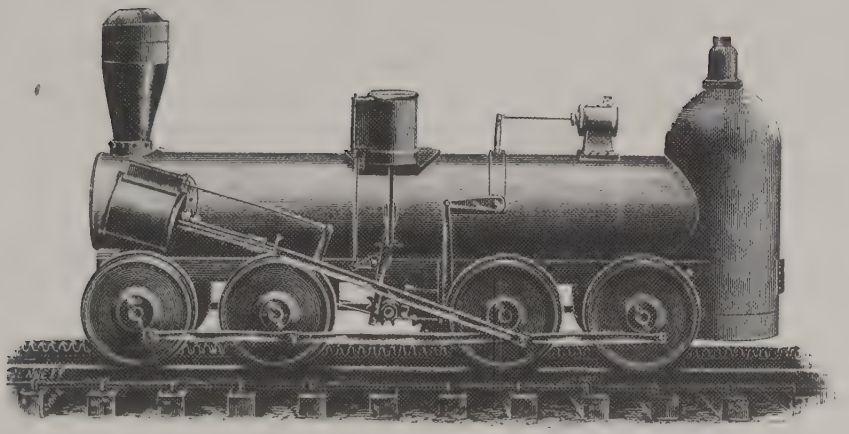
Mount Holyoke, Massachusetts, c. 1860. (Putnam photo.)

Cog railways.

By trial and error, he developed variations of cog locomotive and track systems, working them out in model form. Marsh did not invent the concept of a cog railway—or as it is often called, a rack railway. He was the inventor of the Mount Washington Railway, the first mountain-climbing cog railway in the world. He told writers who interviewed him, as one reported, "The appliance of cogs to a railway track is by no means a new idea; the very first railroad built in England having used them." Marsh was referring to the level steam railway developed by John Blenkinsop for a colliery at Leeds in 1812. Blenkinsop and other early railroad inventors expected that even on level grade, round wheels on smooth rails would merely slip or spin in place. Within two years after Blenkinsop successfully introduced his railroad, it was realized that the adhesion of round wheels to smooth



BLENKINSOP, 1812; MIDDLETON COLLIERY RAILWAY.



Rack Railroad Locomotive, 1848; Madison and Indianapolis Railroad.

rails was sufficient to propel an engine on level grade or even up a slight incline. Although Blenkinsop's cog device became irrelevant to railroad designers, it was illustrated in many mid-nineteenth century engineering textbooks.

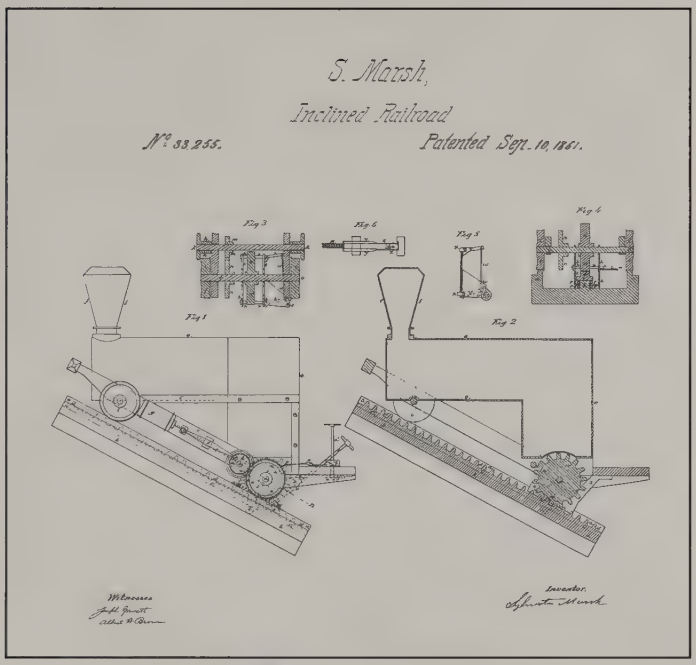
An early scheme that Marsh developed called for a locomotive propelled by a pair of cogwheels that gripped two outside rails. He realized it was "impractical, as every mechanic will see he must necessarily go in a straight line." A railroad running in a straight line up the side of Mount Washington was, of course, inconceivable. He concluded that his locomotive must be able to turn curves so the road might better conform to the mountain contours.

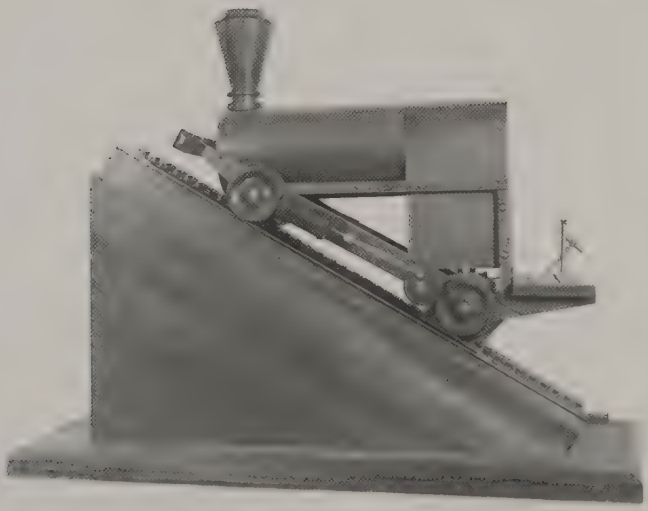
Marsh focused on a locomotive that could climb by a central cogwheel. That principle, he found, was in operation elsewhere. In 1849, Andrew Cathcart had patented the design for an engine that used four pairs of driving wheels to run level by adhesion and used a central cogwheel to help climb a slope. Cathcart's locomotives, operating from 1847 to 1868, ran from the Ohio River to Indianapolis. At Madison, Indiana, they climbed 406 feet over a distance of 1.3 miles with an average grade of 6 percent. For the Indiana railroad, Philadelphia's Matthias W. Baldwin built two such twenty-ton locomotives, large engines for their time.

A design, a patent, and a charter.

Marsh's final design for his inclined railroad is shown in the drawing and model he submitted in 1858 for a patent titled, "Improvements in Locomotive-engines for Ascending Inclined Planes." The patent was granted in 1861. The drawing shows a locomotive climbing a slope of 1 in 2, or a 50 percent grade. In his design a central cogwheel engages a toothed central rail. Two pairs of outer, flanged wheels have neither power nor braking ability, but only support and guide the engine. Marsh's improvement, designed "to ascend very steep grades," is a light, rather than heavy, locomotive, geared to produce the greatest power practical. He wrote in the description, "It has heretofore been customary in the construction of locomotives for ascending inclined planes to [use] ... a large engine of great power." By substantially gearing down, he wrote, "a light locomotive ... can be successfully used." Today the driving rods of Mount Washington engines seem to flail frantically as the cogwheel turns slowly. Speed is sacrificed for power. Marsh showed the boiler mounted so that it would be level on the steep slope. For safety, a major concern, he indicated several ways of braking, and he proposed other improvements: a ratchet that would engage a cogwheel to prevent any backward movement during the train's ascent and a gripper that would extend under the projecting flanges of the central rail to prevent the cogwheel from disengaging. (The latter device was used only for three years on the earliest locomotives.) His friend, Boston's Holmes Hinkley, then New England's largest locomotive manufacturer, agreed that Marsh's lightweight, geared-down, cog locomotive could climb Mount Washington.

When he applied for a state charter in June 1858, Marsh demonstrated a small wind-up model of his invention to the New Hampshire legislature. That model has not survived, but undoubtedly it looked a lot like the patent model he submitted two months later. Few legislators could grasp the concept. As he later reported, he was taken aback by the "universal burst of laughter." One wit famously proposed an amendment to "let him build a railroad to the moon." The



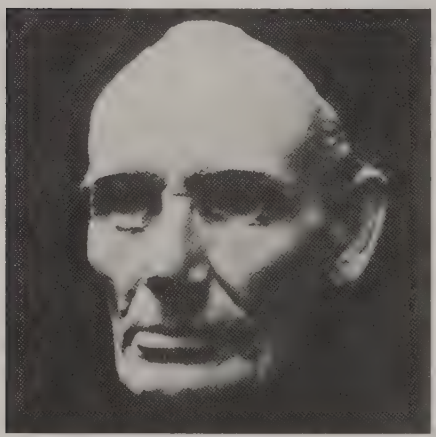


Marsh's U. S. patent drawing and model. (Model in the collection of the National Museum of American History, Smithsonian Institution.)

episode heralded several years of public disbelief and ridicule. Letting him "fool away his own money," the state granted him a five-year charter to build cog railways on Mount Washington and Mount Lafayette.

An interruption.

For more than three years, unexpected demands of his Chicago business interests prevented further work on the project. One concern was a lawsuit, *Johnston versus Jones and Marsh,* known as the "Sandbar Case." It had been entangled in courts for more than a decade. At stake was whether Marsh and William Jones had proper legal title to over 1,000 feet of frontage on the Chicago River, property the *Chicago Press and Tribune* then estimated to be worth more than half-a-million dollars. To defend their ownership, Marsh and his partner hired the ablest Illinois lawyer they knew, Abraham Lincoln. Lincoln took the case in 1858, but it didn't come to trial until April 1860. Consequently, the eight-day jury trial at Chicago's Federal District Court was Lincoln's last appearance in court, as one month later in Chicago he was nominated for the presidency. Lincoln—and Marsh and Jones—won. Once this dispute and other business matters were resolved, Marsh again turned his attention to his mountain project.



Life mask of Abraham Lincoln, made at the time of the Sandbar Case trial, 1860.

Developing his scheme.

In 1863 Marsh returned to New Hampshire and obtained a five-year extension to his state charter. To promote the project, he published his proposed scheme, now with a vertical boiler, in *Scientific American.* He developed two needed refinements to his cog system. The first, an airbrake,

Scientific American.

A WEEKLY JOURNAL OF PRACTICAL INFORMATION IN ART, SCIENCE, MECHANICS, CHEMISTRY AND MANUFACTURES.

Vol. X.—No. 10. (NEW SERIES.) NEW YORK, MARCH 5, 1864. SINGLE COPIES SIX CENTS. $2 PER ANNUM—IN ADVANCE.

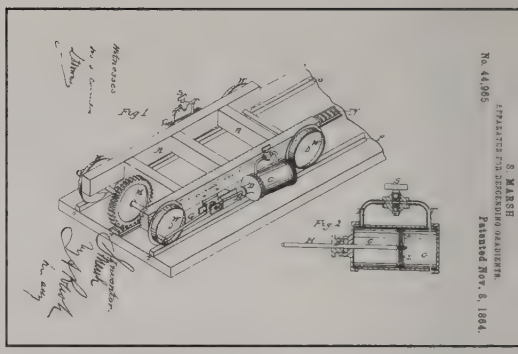
MARSH'S PLAN FOR ASCENDING THE WHITE MOUNTAINS BY STEAM.

As the cost of building railroads is very much increased by the natural inequalities of the country through which the line runs, it is apparent to the most superficial thinker that if engines could be made to disregard these inequalities and ascend or descend steep grades with as much facility as ordinary engines run over levels, one great expense in the construction of railroads would be very much reduced. The subject of ascending heavy grades by loaded cars has long attracted much attention among railroad authorities and those concerned in such enterprises, and many lives are now working whereon trains are daily drawn up acclivities of very sharp angles with the ordinary surface of the earth. These lines, however, dodge the question, so to speak, as they do not accomplish the object by the direct application of the engine to the train, but through the agency of stationary engines and wire ropes wound on windlasses. In this manner a very steep incline at Mauch Chunk, Pa., is worked. On the Baltimore and Ohio Railroad, the trains run over the Alleghany Mountains by winding along the sides in a zig-zag manner, or as a sailor would say by tacking back and forth until the summit is passed. This plan increases the distance enormously, although the object is attained.

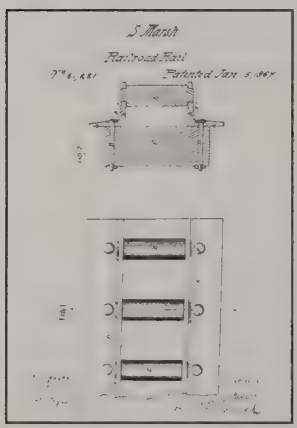
In England this subject is attracting considerable attention at the present time, in consequence of experiments recently made by an inventor named "Fell," who, on a certain occasion, ascended a very steep incline of 1 foot in 12, distance—300 yards, and another of 1 foot rise in 13, length—500 feet, with a 15-ton locomotive and over cars loaded with 20 tons of ballast. He ascended and descended this grade with the utmost facility, the principle he adopted being a central track between the two others and track being gripped by two strong wheels worked horizontally or with their axes vertical. This English plan is nothing new, as we ourselves rode on an engine (on this city) which ran on a vacant lot in 23d street, some 16 years ago, the track and engine being constructed the same as Mr. Fell's. We may add that it was the invention of an American mechanic, named "Sass," and the experiment was successful.

The engraving herewith presented represents a new plan for a "mountain" locomotive; it is the invention of Sylvester Marsh, of this city, and is intended to overcome the steepest gradients and very sharp curves with facility and safety. The engine is a "pusher" and has a vertical boiler, as shown; this pass being perforated and joined indispensable on account of the nature of grades, or the difference which exists between them. This boiler sets in the frame, A, which also sustains the engine, the fuel, and the water tank. The fuel is carried forward and requires the services of an additional hand, or it may be carried on the foot-board of the engine if desired; the water tank is directly under the foot-board at B; it is between the frame and so constructed so as to be out of the way of the machinery. The engines are of the usual locomotive pattern, outside, connected and

appears to be the first time compressed air was used to retard the movement of a railroad train. Marsh's 1864 patent preceded George Westinghouse's first airbrake patent by five years. It may have been Marsh's most creative invention. He would attach airbrakes to his railway cars and adapt the same concept to the locomotive's cylinders. For a steep railway, his "atmospheric brakes" would be as important for the train's safe descent as his earlier design was for its ascent. (Decades later, technical improvements made steel drum-brakes more practical for use on the cars, but cog locomotives still depend on the compression of air in their cylinders for braking when descending mountains.) In place of the earlier toothed central rail, Marsh developed a substantial open-rung ladder rack that would provide a more secure purchase for the cogwheel while also allowing snow and debris to fall through.



Marsh's airbrake patent.



Marsh's central rack patent.

On the west side of Mount Washington, between 1863 and 1865, Marsh bought an inn, the White Mountain House, and more than 16,000 acres of land (25 square miles), a large part of the Ammonoosuc valley. He located the base station at the site where the Ammonoosuc River flowed onto his property. His older son Frank had studied engineering and surveying at Rensselaer Polytechnic Institute. The two laid out a six-mile access road along the north bank of the river from the public turnpike (now route 302) at Fabyans to the proposed station. From

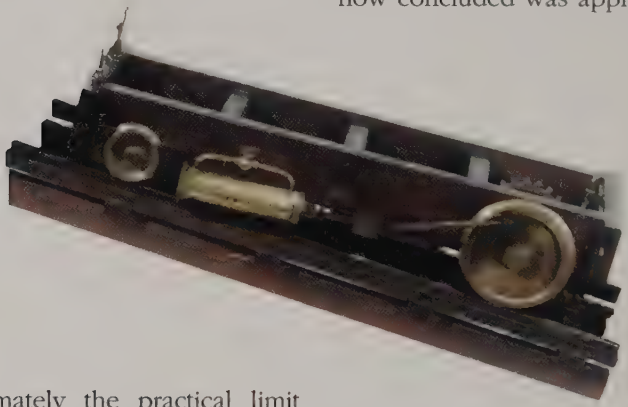
there, generally following the old Fabyan bridle trail, they mapped a rail route of 2.8 miles up the mountain. It would take an average slope of 25 percent with a maximum grade of 37 percent, to climb the 3,625 feet to the summit. The route to the summit would be acquired by eminent domain, the main benefit of the state charter.

A different problem.

A major hurdle remained. To make the railway profitable, more than a hundred tourists were needed every day. The base station would be remote, deep in a forest twenty-five miles from the end of the nearest main-line railroad, the Boston, Concord & Montreal (BC&M) Railroad's White Mountain division in Littleton. How would people get to the Cog Railway? Where would they stay? To Marsh the solutions were obvious: extend the BC&M to his railway and build a big hotel nearby. Marsh predicted, as one interviewer wrote, "Passengers will take [railroad] cars in New York, check their baggage to the Tip-Top House, and with only one change of trains, see the sun rise in Gotham one day, and from the top of Mount Washington the next." The writer added, "Mr. Marsh proposes, as soon as his railway is completed, the erection of a large hotel."

Mount Washington, with Littleton in the foreground. (Keystone photo, c. 1905.)

Marsh had to convince BC&M President John E. Lyon and its General Manager Joseph A. Dodge of the feasibility of his plans. He described his vision in a letter. Lyon said he thought the letter "was from some crazy man." To convince doubters, Marsh displayed a working model and twenty feet of track in his Boston office. The track was set at a pitch of 1 in 3, the grade that Marsh now concluded was approximately the practical limit for his system. When fired up, the little seventeen-pound locomotive chugged up the track pushing a car loaded with a fifty-pound weight from one floor to a room on the floor above. When the little train reached the top of the track, Marsh set the engine's airbrakes and those attached to the car, and separately the engine and car slowly descended back down the track.

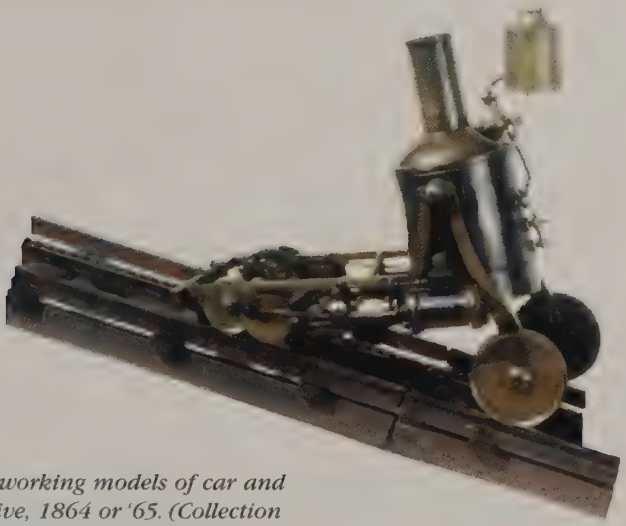


Holmes Hinkley, who had built fourteen of the BC&M's seventeen locomotives, assured them he believed Marsh's devices would work. Josiah Quincy, founder and first president of the BC&M, enthusiastically supported Marsh. Two of Lyon's colleagues, Nathaniel White, co-founder of Cheney Express Co., predecessor of American Express, and Henry Keyes, president of Vermont's Connecticut and Passumpsic Rivers Railroad, endorsed the project. Reluctantly Lyon and Dodge agreed: if Marsh, at his own risk, demonstrated on the mountain that his invention worked, they would extend their line. If he could get other northern railroads that would benefit from increased tourism to invest in the project, the

BC&M would take stock in Marsh's railway company. Investing in his railway would ensure their commitment. This collaboration would lead to Marsh's greatest success—and his biggest disappointment.

The demonstration.

In the fall of 1865, the Marsh family moved to Littleton. The following April, Marsh led a crew into the site to start opening the access road. The next month, with another crew, he started constructing the first 40 rods (660 feet) of the hand-hewn trestle for the roadway. The section crossed the Ammonoosuc and included a 32 percent slope. In Boston, son Frank oversaw building the experimental, four-ton locomotive Number One at the machine shop of



Marsh's working models of car and locomotive, 1864 or '65. (Collection of N. H. Historical Society. Gift of Cornelia H. Marsh, 1885.)

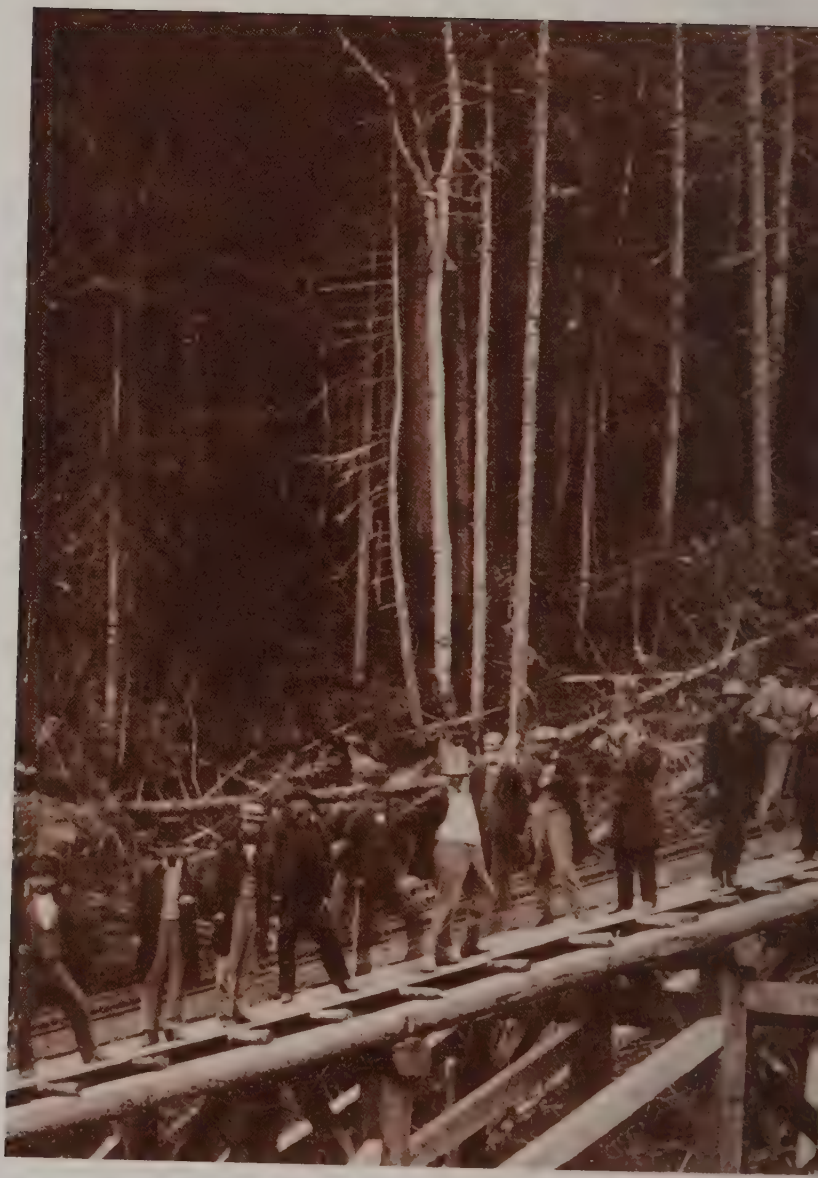
Campbell, Whittier & Co. That company's advertisement in the *American Railway Times* read, "Steam Engines and Machinery, Boiler Work of all Descriptions, Made at the shortest notice." (The engine later would be nicknamed Peppersass—pronounced in the local dialect—by people who thought it looked like a pepper sauce bottle, then a

common item on dining tables.) Once built, Frank took the engine apart, brought it to Littleton by train, hauled it by ox-cart to the site and reassembled it. A simple flatcar with cogwheels and airbrakes was also built.

On a late summer evening, several dozen invited railroad-executives, engineers and reporters gathered at the White Mountain House. The following morning, August 29, 1866, they were trundled over the half-finished road to the base camp. As they approached through the forest, the whistle of Peppersass greeted them. For two hours the visitors were pushed up and lowered down the section of track several times. "The engine works to a charm," reported the *Boston Journal*. "Not even the croakers and doubters hesitated a moment to get on either the car or engine and make the trip."

On August 29, 1866, after demonstrating it could push the flatcar loaded with passengers to the top of the track, Peppersass has returned to the base. The car shows the reliability of its airbrakes as it independently descends. (Kilburn photo.)

In upper left frame, wearing overcoat and top hat, Sylvester Marsh stands at the right of a group of men watching the scene. Next to them is a stereoscopic camera on a tripod and its photographer, probably either Benjamin or Edward Kilburn.



The New York Times reported that after the demonstration of August 29, 1866, "the solid men of New England, who were there a hundred strong, expressed their entire satisfaction, and took off

their hats to be photographed." Sylvester Marsh, in overcoat, stands fourth to the right of the boiler. John E. Lyon, with balding head bowed, stands five further to the right. (Kilburn photo.)

Peppersass, 1866. (Kilburn photo.)

2. Success and Disappointment

Until the Cog Railway demonstration, Marsh had been working entirely at his own risk. After that event, the *Boston Journal* concluded, "The entire and certain success of this amazing enterprise must now be conceded," and the Mount Washington Railroad Company (MWRY) assumed responsibility. Its board of directors elected Marsh as president. As treasurer, they elected John E. Lyon, the president of the BC&M. Both men would keep these positions for life. Stockholders paid in an initial $20,000, and Marsh continued building his road.

Designing and building.

Because safety was a paramount concern, Marsh had the central iron rack fabricated at the Machine Company of Boston where quality could best be assured. The BC&M Railroad brought 230 tons of finished track to Littleton and

ox-drawn wagons hauled them to the mountain site. The cost of the central rail alone would equal a third of the total project cost. If investors were eventually to make money, all other construction costs had to be kept down. Marsh's 1864 illustration in *Scientific American* shows he had intended to provide a smooth roadbed for the track and to erect a handsome masonry viaduct at Jacob's Ladder. To save time and money, however, he opted to install the tracks on wood stringers and trestles. During the recent Civil War, Union General Herman Haupt had become famous for building "Lincoln's railroads" on wood trestles almost faster than Confederates could tear them up. For the two outside rails of the track, Marsh chose to use inexpensive flat strap-iron, adequate to carry his light trains.

Peppersass, a small wood-burning locomotive with a vertical, un-insulated boiler and two cylinders, was—except for its driving gear and cannon-metal cogwheel—a study in frugality. Marsh later referred to it as "a small cheap engine built for the experiment." It was intended only to serve for the demonstration and for the construction of the road, a trial period that would provide the experience needed to design future passenger locomotives.

The experimental period would be useful. Marsh originally had suspended Peppersass's boiler so it could swing,

First building at base station, 1866.

Workers posing with their tools, c. 1868.

always remaining vertical as it traveled the changing grades of the mountain. As a result, water in the boiler stayed nearly level, ensuring the even steaming that's needed for steady power. After two years' experience, however, Marsh concluded that it would be almost as effective and a lot more practical to fix the boiler at an angle reflecting the average 25 percent grade of the route. Sloped boilers have been a distinctive feature of cog steam locomotives ever since. Responding to unique conditions, Marsh was still designing.

A deadline.

By late July 1867, Marsh had installed a little over a mile of track in an almost straight line to the point where a water-tank was erected at the intersection of the route with the Waumbek Path. Almost two more miles as well as the largest trestles and most curves were yet to be built, and by state charter, only one year remained for the railway to become operational. The company charter also contained an interesting provision: state railroad commissioners would determine the cost of the land-taking from the base to the summit, and the commissioners were known to set low appraisals. Company directors feared that if an extension from the state were required, the legislature might eliminate this valuable feature, and a lawsuit could result in a very high cost. Indeed, when the MWRY later applied for and got

Peppersass at Jacob's Ladder, 1868.

Construction, 1868.
(All photos by Kilburn.)

an extension, the provision was deleted. In order to speed construction, the directors agreed that the experienced BC&M should take charge of completing the line. Joseph A. Dodge, the BC&M's manager, appointed J. J. "Job" Sanborn, their chief bridge-builder, to supervise construction. "He built the remainder of the road, following out almost precisely the same principles and methods I had employed," wrote Marsh later. To meet the deadline, the BC&M contracted with the Aiken Machine Shop of Franklin, New Hampshire, for a second work-locomotive, almost a replica of the first. The shop was headed by thirty-six-year-old Walter Aiken, who was well-known to Sanborn and related to Dodge by marriage.

President Grant and party pose at Waumbek tank. Grant, third man from left, stands with his wife and two children beside him. Marsh, in top hat and with white beard, stands the fifth person to the right of Grant, 1869. (Kilburn photo.)

Success.

On August 14, 1868, after Sanborn and a crew of twenty-seven men had completed the trestle over Jacob's Ladder, the MWRY held its inauguration. The Cog Railway and Sylvester Marsh became celebrated. The *Boston Transcript* called the railway "one of the greatest wonders of the time."

The *New York Times* concluded, "The Summit Steam Railway is an idea of Mr. Sylvester Marsh. ... It is intended not merely to facilitate ascent of the big hill, but to revolutionize the whole system of mountain travel. Hitherto there has been but two ways of conquering the inequalities of the earth's surface—by going around or through them. Mr. Marsh proposes to obviate this by going over them." Among the sixty guests—reporters and railroad executives—at the opening were the three state railroad commissioners. They agreed the schedule had been met and set the cost for the 99 foot-wide corridor up the mountain at $91.50.

Aiken's rebuilt engine and a Marsh developed open car, c. 1869. (Kilburn photo.)

Early the following summer, July 3, 1869, the road was completed to the summit. Two months later, in a publicity coup, Ulysses S. Grant arrived to ride the new mountain railway. "The President passed some minutes in examination of the locomotive used in this novel piece of engineering skill, and was particularly struck with the simplicity and safety of the air brake," reported the weekly *Leslie's Illustrated Newspaper*. "Everything of importance connected with the construction and running of the railroad was explained by the patentee of the road."

Hotel coaches at the new Marshfield depot, c. 1870. (Kilburn photo.)

Conflict.

Marsh's problems, however, weren't over. From what transpired, it's apparent that Lyon and Dodge had decided that since the BC&M's future now was tied to this venture, it would be better for their interests if the strong-willed, independent inventor were not in charge. Walter Aiken was an ambitious businessman and mechanic with the familial loyalty that Lyon and Dodge preferred. Treasurer Lyon paid the BC&M and Aiken for their services in stock rather than cash. On that basis, Aiken's shop was commissioned to re-build the second engine and produce three passenger locomotives—and Aiken became the third largest stockholder.

Marsh was critical of the locomotives. They were larger and heavier versions of his experimental engine, and they required all the strap-iron rails to be replaced by conventional and more expensive T-rails. Correspondence shows that Marsh's comments and advice were ignored. He found his patented improvement to the airbrake on the trash pile. His design for a sliding-platform switch with a siding that would allow up and down trains to pass—a useful device for a single-track line—was dismissed and forgotten. (A turnout switch with a siding would not be built at Mount Washington until 1941.) A distressed Marsh asked to buy back all the stock, but his request was brushed aside.

A new design.

In 1870, Captain John W. Dodge, who was Joseph A. Dodge's cousin as well as Walter Aiken's father-in-law, was appointed manager of the railway. Marsh's advice continued. By the spring of 1871, Marsh had filed a caveat to his existing patent for a new locomotive. His new engine design featured a horizontal boiler, which would be more efficient; four cylinders rather than two, which would be more powerful; and power for climbing and braking transmitted to two cogwheels rather than one, which would be much safer. Marsh recommended his improved design to the MWRY, but for four years the company continued to build and operate engines with vertical boilers.

Holmes Hinkley hadn't lived to see the successful demonstration of the Cog, and following his death in 1866,

The first locomotive with a horizontal boiler, 1875. (Kilburn photo.)

the BC&M bought their next twenty-five locomotives from Aretas Blood, founder/owner of New Hampshire's Manchester Locomotive Works. Blood was brought into the MWRY design debate, and he came to agree with Marsh. In 1875 Blood's locomotive works built Hercules, a cog locomotive with a horizontal boiler that followed Marsh's caveat. It set the standard for every engine built to the present day. Within three years, all four of Aiken's engines were scrapped and replaced, and the Manchester Locomotive Works would provide all MWRY engines for the next thirty-three years.

Another disagreement.

The most serious disputes concerned not design, but policy and ethics. Marsh believed that, as at Mount Holyoke, the railway should own its own summit depot-hotel. Against Marsh's objections, the company allowed Aiken to build and own a new Summit House hotel on the railway's narrow property—a unique site for free. The BC&M furnished 50 percent of his financing, ensuring Aiken's greater involvement with the railway. When Marsh discovered that Aiken was using the Cog Railway, also for free, to construct his Summit House (250 trips for which he never paid—more trips than were run with passengers then, during a typical

season), Marsh charged Aiken with "conflict of interest" for using the railway for his own benefit. The protests were ignored.

Marsh's loss of control can be traced in the treasurer's records. In 1867, when funds were first raised, Marsh and his supporters, Nathaniel White and Henry Keyes, received 50 percent of the stock. The remainder was held by the BC&M and two other northern railroads that did business with the BC&M: Marsh's influence and that of the BC&M were equally balanced. By 1871, when most capital improvements had been completed and $129,000 spent, Marsh and White owned 32 percent of the stock. Keyes had died, leaving the BC&M, Aiken, and five northern railroads holding the rest. In any disagreement, Marsh could be outvoted two-to-one.

Marsh kept these disputes private. He wrote, "I feared it would injure the reputation of the road if the public knew I was dissatisfied or had withdrawn from the company." Earlier Marsh hadn't been disturbed when newspapers called him "a lunatic," but he found being reduced to a figurehead "humiliating." The rest of his life he retained the title "President of the Mount Washington Railroad," but he put most of his energies into other projects.

The Summit House under construction, 1872. (Burned in 1908, its replacement was demolished in 1980. Kilburn photo.)

The final pieces are put in place.

In 1871 Marsh sold the White Mountain House, the nearby inn that he had bought six years earlier, and the following year, holding the majority of stock, he headed a company that built Fabyan House. A grand hotel, it was located on his property at the entrance to the base station road and was advertised to "well accommodate Five Hundred Guests." By 1875 two railroads met at Fabyans: the BC&M from the west and the Portland and Ogdensburg from the east. A third road

A train and stagecoaches arrive at Fabyan House, 1874. Crawford Notch is shown in the distance.

was under construction, a BC&M branch line connecting Fabyans directly to the Cog Railway.

The original (and present) MWRY base station, named Marshfield, stands six miles from Fabyans and at an elevation 1,150 feet above it. Logically, the link-up with the Cog was planned for a location as close to Marshfield as a conventional train could climb, and the Cog Railway would be extended down to that point. Adhesion locomotives of the time, however, could only run to a point that was two miles short of Marshfield, while extending the Cog Railway two miles meant the slow-climbing cog trains would take substantially longer to reach the summit. Again, Aretas Blood solved the dilemma. In 1876 his Manchester Locomotive Works built, especially for the BC&M branch line, a 29-ton locomotive with three pairs of driving wheels, the first so-called Mogul engine in New England. Named the Mount Washington, for many years it would be the most powerful locomotive in the northern states. Consequently in June 1876, at a junction just one-quarter-mile west of Marshfield, the connection was completed. Railroads now connected the summit of Mount Washington with all major eastern cities as Marsh had envisioned.

Junction of the BC&M and the MWRY, c. 1883. Marshfield and the mountain are in the background. (Kilburn photo.)

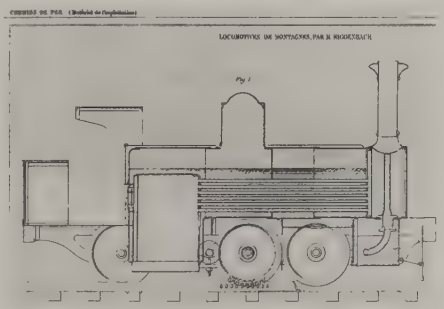
Three railroad lines now converged at Fabyan House, and it became the center of summer activity. Such activity stimulated others to build more hotels. By 1895, a nearby Mount Pleasant House could accommodate 300 guests. In 1902 on a close-by hilltop, the grand Mount Washington Hotel opened, its grounds encircled by the BC&M branch line to Marshfield. (The branch line was taken up in 1932. Mount Pleasant House was demolished in 1939, and in 1951 Fabyan House burned.) Today the Mount

The Mount Washington Hotel, c. 1912.

Washington Hotel remains the elegant survivor of the fashionable enclave developed along the rail entry to the Cog Railway. New hotels and tourism were thriving, but Marsh's interest continued to focus on mountain railroads.

A visitor from Switzerland.

The difficulties, even opposition, Marsh met from his own railway company, were in contrast to the enthusiastic response of the Swiss. Like many Americans of the time, Marsh felt partial towards Switzerland, a nation whose government recently had adopted a democratic constitution modeled after that of the United States. Like his acquaintance, New Hampshire Senator George Fogg, who had been Lincoln's Minister to Bern, Marsh also recognized how useful his mountain-climbing invention might be to the Swiss. In April 1867, Fogg brought the Swiss Consul General (the acting ambassador) John Hitz, Jr., as his guest to Littleton to meet Marsh and see the "experiment." Marsh gave Hitz stereophotographs and drawings of the railway and offered the Swiss *gratis* his patents and advice. The Swiss government left the matter in Hitz's hands. When he returned to Switzerland, Hitz visited Niklaus Riggenbach, a locomotive works manager and engineer who once had promoted, without success, his own design for a cogwheel locomotive. Riggenbach's earlier design, for which he had received a French patent in 1863, was for a locomotive, like Andrew Cathcart's, intended to pull through-trains up occasional grades of 5 percent or so—but not up the steep slopes of a mountain. When Riggenbach saw the photographs and descriptions of Marsh's mountain-climbing locomotive and airbrake, he instantly recognized their potential. He sent for Hitz's government report, and when he returned it, he wrote in a note to the Swiss Chancellor, "If it were ever possible, I would



Niklaus Riggenbach's 1863 French patent.

endeavor to use this system on the Rigi." (Located on Lake Lucerne, Mount Rigi, comparable to Mount Washington in height, was then the most frequently visited mountain in Europe.)

Riggenbach contacted Marsh, proposing they be equal partners in the development of Europe's first cog railway. Marsh declined but still offered his cooperation. In June 1869, an assistant to Riggenbach, Swiss engineer Otto Grüninger, stayed a week in Littleton, part of the time with the Marsh family, while he compiled a detailed report and produced numerous sketches that described the construction and operation of the MWRY. A year later in Switzerland at the lakeside village of Vitznau, while a force of 600 laborers was starting to build the railway on the mountain above, Riggenbach demonstrated his locomotive Number One, quite similar to Peppersass. On May 21, 1871, his railway opened with elaborate ceremonies. The Mount Washington Railway in its first summer of operation had carried about 5,000 passengers. In its inaugural season, the Vitznau-Rigi Railway had 60,000 riders. By 1876 Riggenbach had completed, or was constructing, five more similar railways.

Riggenbach's first locomotive, at base of Mount Rigi, Vitznau, Switzerland, 1870.

By 1876 the Cog Railway and White Mountain tourism were flourishing, and John E. Lyon had developed a new respect for Marsh. "I was glad to hear that Mr. Lyon was showing a favorable disposition," Frank Marsh wrote his father. Records show that by then, Marsh was planning three new cog railway projects, and Lyon joined him as a partner

in them. One project involved Niklaus Riggenbach; none included Aiken. But nothing came of these plans as human calamities intervened. In 1877 both of Marsh's sons, thirty-two-year-old Frank and twenty-one-year-old Sylvester Jr., after "lingering illnesses," died within two months of each other—a cruel blow. The next year, Lyon died accidentally in a fire, and Marsh gave up further railway ventures.

The Swiss design more cog railways.

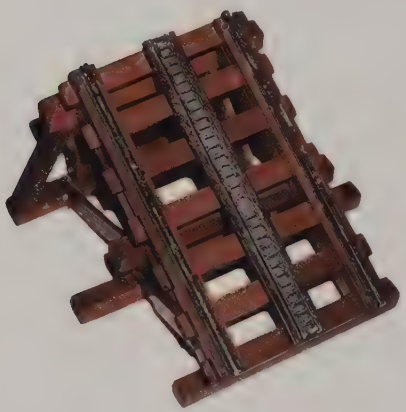
In the fifteen years following the completion of the MWRY, twenty-six railways were built using a Marsh/Riggenbach ladder-type central rack. In 1885, Roman Abt, who for eight years had been Riggenbach's chief designer, introduced his own improved system with a central rack composed of offset toothed rails. Abt's system provided a slightly smoother and faster ride, and most cog railways built since then have adopted that system.

Cog railway at summit of Pike's Peak, c. 1890's. (Hersom photo.)

Nineteen years after he had stayed with the Marsh family in Littleton, Otto Grüninger, working with Roman Abt, designed the cog railway that opened in 1891 at Pike's Peak in Colorado. Since the MWRY's completion, fifty-seven mountain-climbing cog railways and 120 dual-traction railways (railways that run both level by adhesion and up-and-downhill by cogwheel) have been built in thirty-five countries. Some lines do a big business. The thirteen mountain-climbing cog railways of Switzerland carry a combined total of ten million visitors-a-year to the summits of the Alps. Worldwide, almost all the railways follow Swiss designs—developed from Marsh's work at Mount Washington.

Aiken makes a claim.

After the death of John W. Dodge in 1875, Walter Aiken had become manager of the MWRY. His foray into locomotive-building had led nowhere, but he gained control of the railway. He now attempted to share—or maybe to usurp—the recognition that Marsh was receiving as the inventor and "projector" of the Cog Railway. In 1877 Aiken's Summit House sponsored a summer newspaper, *Among the Clouds*, and in an early issue Aiken wrote his own brief history, "Cog Railroads." Notably, he claimed his own father, Herrick Aiken, around 1847, had invented and laid out the route of the Mount Washington Railway but had been talked out of building it. (This would have been nine years before the Mount Holyoke Railway opened, and when there was no railroad within ninety miles of the base station site.) As evidence, Aiken had available his father's model of the track, but he never offered more explanation. At the time, Aiken's claim made little impression. *Among the Clouds* appears to have been the only publication in Marsh's lifetime to mention Herrick Aiken's possible role—but Walter Aiken's assertion has baffled every modern White Mountain historian since.



Aiken's purported 1847 model. (Collection of Rogers B. Johnson.)

In 1960, author F. Allen Burt found what he thought were the words of a witness, a letter by Herrick Aiken's granddaughter, written to support the claim. The 1927 letter told of Marsh's many visits to their home where he discussed the model and the details of building the railway. What Burt apparently didn't realize was that the letter was family hearsay. The writer was born in November 1867, after her grandfather had died and half the railway had been built.

The suggested Herrick Aiken model, still in descendants' hands, could have convinced a curious tourist in 1877, as its details are identical to the track then—and to the track today. Few viewing the model would have known that the track design had evolved over time. Marsh's 1864 drawing indicated the track on-grade, not on a trestle where he later placed it—and that's indicated in the model. In 1858 Marsh had proposed a toothed central rail. Only after 1864 did he develop and later patent the open-rung central rack that he used—and that's shown on the model.

Marsh's response to Aiken's claim can be found in an 1878 letter to Emmons Raymond, Henry Keyes's successor as president of the Connecticut and Passumpsic Rivers Railroad. Marsh wrote, "I built the first engine and quite a piece of the Road before Mr. Aiken knew anything about it." Why would Aiken make up such a story? Marsh wrote, "This may surprise you until you learn that he has always been jealous of my having the reputation for being the originator or inventor of the Mt. Washington Railroad and its appliances." Marsh expressed little concern for recognition, writing, "This I care very little about, since I have lost both my sons, and shall have no one to reap the advantage I may be entitled to."

Marsh's final years.

In 1880, the *Concord Monitor,* the state capital's leading newspaper, reported, "Sylvester Marsh, Esq., of Littleton, the well known inventor of the Mt. Washington Railway, has bought a residence [in Concord]." All his life he had been a hardworking and inventive capitalist and a socially concerned citizen. A Chicago colleague summed him up, "Put Marsh on a desert island and in thirty days he will be in business, with three men working for him, and every man will be wearing a new suit." Religiously, Marsh was a staunch Congregationalist. Politically, he earlier had been an anti-slavery Whig, later a liberal Lincoln-Republican. In 1872 he had become a member of the board of directors of the New Hampshire Woman's Suffrage Association. At his Concord home on December 30, 1884, with his wife and four daughters at his bedside, he died of pneumonia. His obituary in

Cornelia H. Marsh, 1896. (Marshall photo.) Sylvester Marsh, 1880. (Kimball photo.)

the *Concord Monitor* was the longest one printed in the paper's twenty-year history up to that time. The MWRY directors sent the following statement to his widow and published it in *Concord's Daily People and Patriot*:

> **Resolved that in the recent death of Sylvester Marsh, Esq., the president of the corporation from its beginning, the board of directors recognize the loss of an associate whose genius and thoughtfulness suggested and originated the enterprise, and whose interest in its welfare and confidence in its ultimate success, whether in adversity or prosperity, never flagged.**

* * *

In 1976 the Cog Railway was designated a National Historic Civil and Mechanical Engineering Landmark. Today Peppersass stands on exhibit at Marshfield station. In recent years, more than 70,000 visitors each summer easily and safely ascend Mount Washington on Marsh's steam railway.

FRANK LESLIE'S
ILLUSTRATED
NEWSPAPER

No. 1,108—Vol. XLVII.] NEW YORK, SEPTEMBER 14, 1878. [Price 10 Cents. By Mail, ...

NEW HAMPSHIRE—THE MOUNT WASHINGTON RAILWAY—A TRAIN OF SUMMER TOURISTS DESCENDING FROM THE SUMMIT HOUSE
From a Photograph by Kilburn Brothers, Littleton, N.H.—See Page 71

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Illustrations

Page 6, map edited from Thomas Starr King's, *The White Hills; their legends, landscape, and poetry*, Boston: Crosby, Nichols, Lee and Co., 1860.
Page 8, 9, drawings from James Dredge's, *Transportation Exhibits at the World's Columbian Exposition,* New York: J. Wiley & Son, 1894.
Page 11, photograph courtesy of the National Museum of American History, Smithsonion Institution, Washington, DC.
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Page 34, courtesy of the Vitznau-Rigi Railway.
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All other illustrations are from the author's collection.
The photograph on the front cover was taken by the author in the fall of 1993.

This booklet was designed by the author, under the patient tutelage of Dan Bridgman, using Adobe Photoshop and QuarkXPress Passport on a Power Macintosh computer. Dan developed the reproduction of the 1869 *Harper's Weekly* article, "Into Cloudland by Cars," to fit the four endpapers.

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Stereography, photography that records an object as in three-dimensions, was used to publicize the railway. Many photographs in this study are from halves of stereoviews. Often stereographers and city reporters were given free round-trip tickets by the BC&M and provided free room-and-board by Marsh at his White Mountain House. When reporters left, they usually took a handful of the latest stereoviews with them. Stereographer Benjamin Kilburn, Marsh's friend and fellow Littleton-resident, established his career with scenes of the railway and the White Mountains and went on to become the largest stereoview publisher in the world.

Sources Consulted

Manuscript Collections

Author's Collection. Marsh family letters.
Dartmouth College Special Collections. Connecticut and Passumpsic Rivers Railroad Company papers and Mount Washington Railroad Company records.
Hartford Seminary Library. (Rev.) A. C. Thompson. Personal Reminiscences, 1842-57, Connecticut.
Mount Washington Observatory, White Mountain collection. Sylvester Marsh's business letters and original patents.
New Hampshire Historical Society. Herrick Aiken II. Aiken Genealogy, 1924.
Rensselaer Polytechnic Institute Archives, Troy, New York.
Swiss Federal Archives, Bern. John Hitz, Jr. Report of Swiss Consul General, 1867.
Swiss Transportation Museum, Lucerne. O. Grüninger. *Installation of Cogwheel Railway Technology on Mt. Washington*, 1869.

Government Documents

Laws of the State of New Hampshire, Private Acts. 1858, 1863, 1869.
Registry of Deeds. Coos County. Lancaster, New Hampshire.
Report of the Senate Committee on Labor and Industry. 5 vols. Wash., D.C.: Gov't Printing Office, 1885.
U.S. Circuit Court, N. H. *E. Coe and D. Pingree vs. W. Aiken, BC&M, MWRY, Concord & Montreal RR*, Manchester, 1893.
U.S. Patent Office. Records. National Archives. Suitland, Maryland.

Articles

Aiken, Walter. "Cog Railroads." *Burt's Among the Clouds*, September 1, 1877.
"Grain Elevators, Cleaners, and Dryers." *Journal of the Franklin Institute* 52 (July 1866).
Marsh, Sylvester. "Brief Outline of the Origin and History of the Mount Washington Railroad." *Mount Washington Observatory Bulletin* 14 (Sept. 1973).
"Marsh's Automatic Grain Dryer." *Scientific American*, Jan. 23, 1864.
"Marsh's Plan for Ascending the White Mountains by Steam." *Scientific American*, Mar. 5, 1864.
Moeschlin, Felix. "N. Riggenbach, S. Marsh und das Rigi-Zahnradbahnsystem. [N. Riggenbach, S. Marsh and the Rigi Cog Railway System.]." *Schweizerische Bauzeitung* Dec. 1945.
"The President's Trip to the White Mountains." *Frank Leslie's Illustrated Newspaper*, Sept. 11, 1869.
Sargent, Jonathan E. "Hon. Josiah Quincy." *Granite Monthly* 8 (1885).
Sulzer, Elmer. "Locomotives for the Madison Hill." *Railway and Locomotive Society* 123 (Oct.1970).
White, John. "Holmes Hinkley and the Boston Locomotive Works." *Railroad History* 142 (1980).

Exhibition

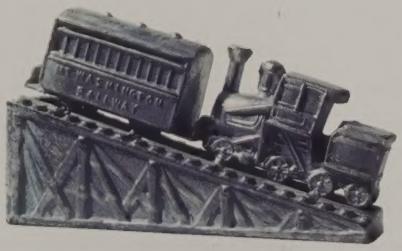
Belknap Mill Society, Laconia. Richard M. Candee, curator. *Those Inventive Aikens: Models, Machines & Mechanic-Inventors of 19th Century New Hampshire,* 1998.

Books and Booklet

Anderson, Leon W. *World's First Cog Railway (booklet).* Concord: Village Press, 1978.
Andreas, Alfred T. *History of Chicago,* 3 vols. Chicago, 1884-6.
Bray, Donald H. *They Said it Couldn't be Done.* Dubuque, Iowa: Kendall/Hunt, 1984.
Baumgardner, Mahlon J. *The Allegheny Old Portage Railroad.* M. J. Baumgardner, 1952.
Burt, F. Allen. *The Story of Mount Washington.* Hanover: Dartmouth Pub., 1960.
Dodge, Joseph D. *Genealogy of the Dodge Family.* 2 vols. Madison, Wis., 1894.
Gilbert, Paul, and Charles L. Bryson. *Chicago and its Makers.* Chicago, 1929.
Graci, David. *Mt. Holyoke, An Enduring Prospect.* Holyoke, Mass.: Calem Publ., 1985.
Hefti, Walter. *Zahnradbahnen der Welt [Cog Railroads of the World].* Basel, Switzerland: Birkhauser Verlag, 1971.
Hitchcock, Charles H. *Mount Washington in Winter.* Boston: Chick and Andrews, 1871.
Jackson, James R., ed. *History of Littleton, New Hampshire,* 3 vols. Cambridge, 1905
Mead, Edgar T. *The Up-Country Line.* Brattleboro: Stephen Greene Press, 1975.
Staffelbach, Hans. *Vitznau-Rigi, First Mountain Railway in Europe.* Zurich: Orell Füssli Verlag, 1972.

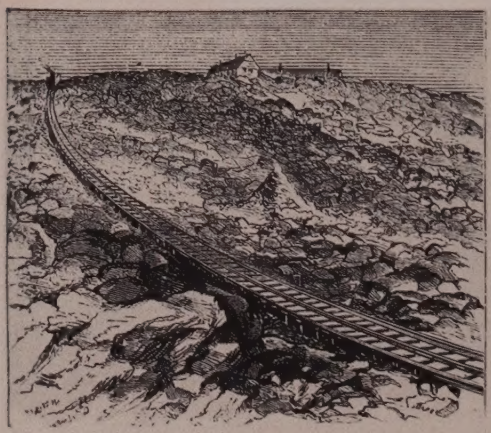
Newspapers

Boston Journal.
Boston Post.
Burt's Among the Clouds, Mount Washington.
Chicago Press and Tribune.
Concord Monitor.
Daily People and Patriot, Concord.
Gem of the Prairie, Chicago.
Littleton Gazette.
New York Times.
Springfield Republican. Massachusetts.
White Mountain Republic, Littleton.



Superintendent, the work slowly but surely progressed. Driven away from their work early in the fall, and not able to recommence until another summer was almost at hand, there were very few weeks of each year in which any work could be done. Last October the laborers were interrupted by a sudden snow-storm without having time to gather up their tools. Under the snow they laid all winter, and not until June could the men go up to lay the remaining five hundred feet of track. In less than a month it was completed; and by the opening of another season there will be a comfortable depot and small hotel at the foot.

We took our lunch, sheltered from the sun, and partially protected from the numerous



TIP-TOP HOUSE.

black flies, in one of the rough buildings put up for the workmen. We availed ourselves of the opportunity to study a little the construction of the cars and track, and carried off some of KILBURN BROTHERS' admirable stereoscopic pictures, which, transferred by the artist to these pages, give the result of our investigations better than we can do in words.

A third track, laid between the other two, is fitted with cogs. A third wheel, both in the engine and the cars, is furnished in like manner. The teeth of the one fitting into those of the other propel both car and engine steadily up the steepest grades. It thus differs from the Mount Holyoke Railway, where a stationary engine pulls you up by a long rope, and from the Mount Cenis Railway, where two little wheels, griping the third rail, propel you by means of friction only. Looking up the track, and realizing that it is really as steep in some places as an ordinary flight of stairs, we almost doubted our courage, and we listened eagerly to Mr. MARSH's kind and detailed explanations of the means which are used to secure the safety of the trains. More than once the ladies shook their heads and turned away from the track, made almost dizzy with looking at it from below. Hark! a whistle! We run to see a black dot smoking a very minute cigar. It comes nearer, and, as we see men and women there, we hold our breath, and when they safely reach us, strangers though they are, we feel like congratulating them that they have safely passed through such an awful experience. We are somewhat rebuffed by seeing them step calmly out upon the platform as if from an ordinary carriage. We are not willing to be outdone, so we think of the atmospheric brakes, of the friction-brakes, of the rachet-wheel, and the cogs, and look very brave. Mr. SANBORN, in spite of some difficulties in the way, most kindly made up a special train. The old and smaller engine, and a common platform-car, with a rough tier of seats upon it, were soon ready. The seats were arranged to be level on an ascent of one foot in five, and when the car is on level ground the seats present that angle. While we were arranging ourselves upon them our predecessors on the road stood by giving us the benefit of their recent experience—counseling sundry tyings on of hats, coat-buttonings, and extra wrappings. But the sun is so hot! Never mind; wait and see how long it will be so.

We start. There are no words—only looks, one at another, and underhand graspings of the seat; and up, up we go, as if pushed from the earth into the air. No place to step off upon. On a trestle-work, sometimes more than twenty feet high, we seem entirely severed from the earth. The stoutest of the party looks a little pale; but we feel the firm grip of cog upon cog; we remember that the wheel is so clamped upon the pin-rigged middle rail that neither the engine nor the car can be lifted or thrown off; that the pawl dropped into the rachet-wheel would hold us in the steepest place; that the shutting of a valve in the atmospheric brakes effectually stops the wheels from moving; we look at our Superintendent, who stands composedly watching the engine; his calmness inspires us with courage, and we dare to look off, and

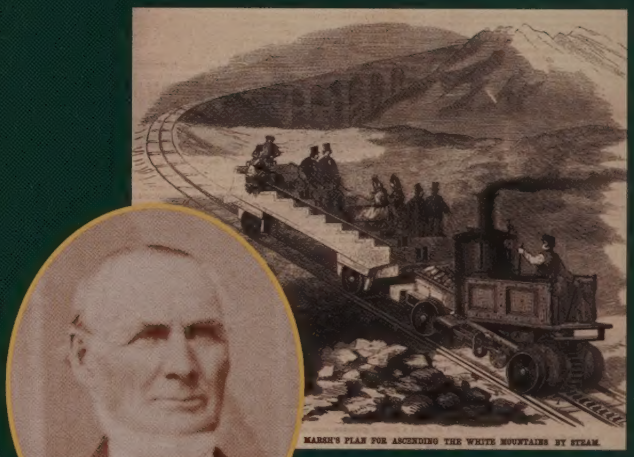
then—we forget all fears. We are ascending so precipitately that unless we look directly behind us up the track, we seem to go up from the middle of a great valley. Hills and valleys, streams and lakes and distant villages, spread out before us with a wonder of beauty that beguiles us of all fear.

Suddenly we become conscious that there are no more black flies. The sun seems not quite so hot. Our wrappings are not quite so oppressive. The trees are not so large. We are still creeping up, up. There are no level places. When we stop to water the engine, it is on a steep grade, and we wonder whether we shall not go whizzing down. But no! We start again, and still up we go. The horizon extends. The trees appear smaller. The flowers are such as bloomed with us two months ago. Admiration gives place to awe. There is no room in our hearts for fear. We care not if the wind is chilly—we drink in the wonder. Another stop for water. There is some consultation between Superintendent and workman. Water is short. Why? Frozen up. Frozen up in July? Sure enough soon we come to a laborer with red, cold hands, who reports frozen ground only a foot below the surface. Think of it, you who were sweltering in the city. But look off: Yonder are distant lakes, lifted up by the sunlight. The mountains about us shrink into small hills, and still we are not at the top. It begins to feel damp. We come to a cloud. What is it like? Like rain? No. Like fog? No. We are saturated, permeated with moisture. It seems almost to drive through us. But now it lifts, and how gloriously the sun lights up the valleys! There are no trees about us, only dwarfed attempts at trees. Now only moss-covered rocks, now bare rocks. Just beside us winds the carriage-road. Now we pass poor LIZZIE BOURNE's rude but most appropriate monument. Now we are at the top. Cloud-wrapped, we see nothing save the rocks just about us. Stepping off the car we are almost thrown down by the wind. Tightly drawing our wraps about us, shutting the driving water out of our eyes, we scramble to the Tip-Top House, and by the blazing fire we have time to consider what we have done.

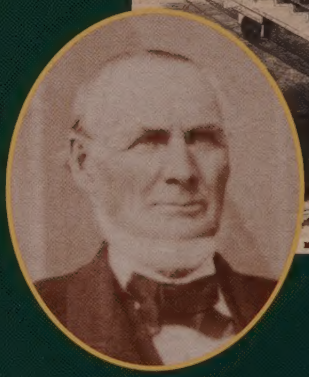
In an hour and a half we have climbed by steam a ladder nearly three miles long. We have ascended in that time over 3600 feet. We are more than 6000 feet above the level of the sea. We have passed from the atmosphere of July to that of January. The stunted vegetation just below is not that of New England. It is the vegetation of Labrador. Shall we dare to go down again, to drop, in some long grades, at the rate of one foot in three? The Superintendent tells us that a car set free would make the descent in less than three minutes. We shudder at the bare thought. He tells us that he can load that car with stone, adjust the brakes, and leave it without a man to operate them, and it will make the descent in safety. We are reassured. There are the atmospheric brakes—if one gives way there are three more to hold; there is an ordinary friction brake with which the engineer tells us he can stop the train in four inches; there is the ratchet-wheel that stops it instantly; and there is the steam in the engine, never used in the descent, but always ready as an additional protection; and, finally, the mechanism is so adjusted that it seems as though not even carelessness in the engineer could well be fatal. It is only the novelty of the situation which inspires fear. That novelty is already gone. And after a good breakfast we descend the mountain-side, exchanging the piercing winds and yet more penetrating clouds for sunlight, throwing off our wintry wrappings, coming from the region of barren rocks to that of stunted vegetation, and from that of stunted vegetation to that of noble forest trees, with less tremor than we often have experienced on the top of an old-fashioned stage among the precipitous hills of Maine.

AMONG THE CLOUDS.

This story summarizes the extraordinary life, career, and inventions of the man behind New Hampshire's Mount Washington Cog Railway. Thoroughly researched, it is illustrated with historical drawings, models, and photographs, many never before published. Marsh achieved great success, but his story is also one of conflict and disappointment.



MARSH'S PLAN FOR ASCENDING THE WHITE MOUNTAINS BY STEAM.



A draft of this study appeared in the Fall and Winter 1998 issues of *Windswept, the Quarterly Bulletin of the Mount Washington Observatory*. Now the author has expanded that article and added forty illustrations.

Guy Gosselin, editor of *Windswept* and former Executive Director of the Observatory, called the work very important. As it contains new information, he wrote, "it is important for the historical record. It is important also, though, for the picture drawn of Marsh. If ever there was a model for integrity, thrift, perseverance, ingenuity and gentle strength, it was Sylvester Marsh."

The Mount Washington Observatory is a nonprofit scientific and educational institution among whose goals is preserving the mountain's unique history.

Author Dick Joslin is an architect in Cambridge, Massachusetts, and on the faculty of Smith College. He also is a great-grandson of Sylvester Marsh.

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